Some Radiator configuration studies for the RICH

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Radiator Configuration

- A proposal for a two radiators arrangement
  Note on the radiator configuration for the RICH of AMS
  M. Buénerd
  ISN-note 00/63 (2000)
- Superimposed radiator scenario (AGL on top of NaF)
- Contiguous radiator scenario

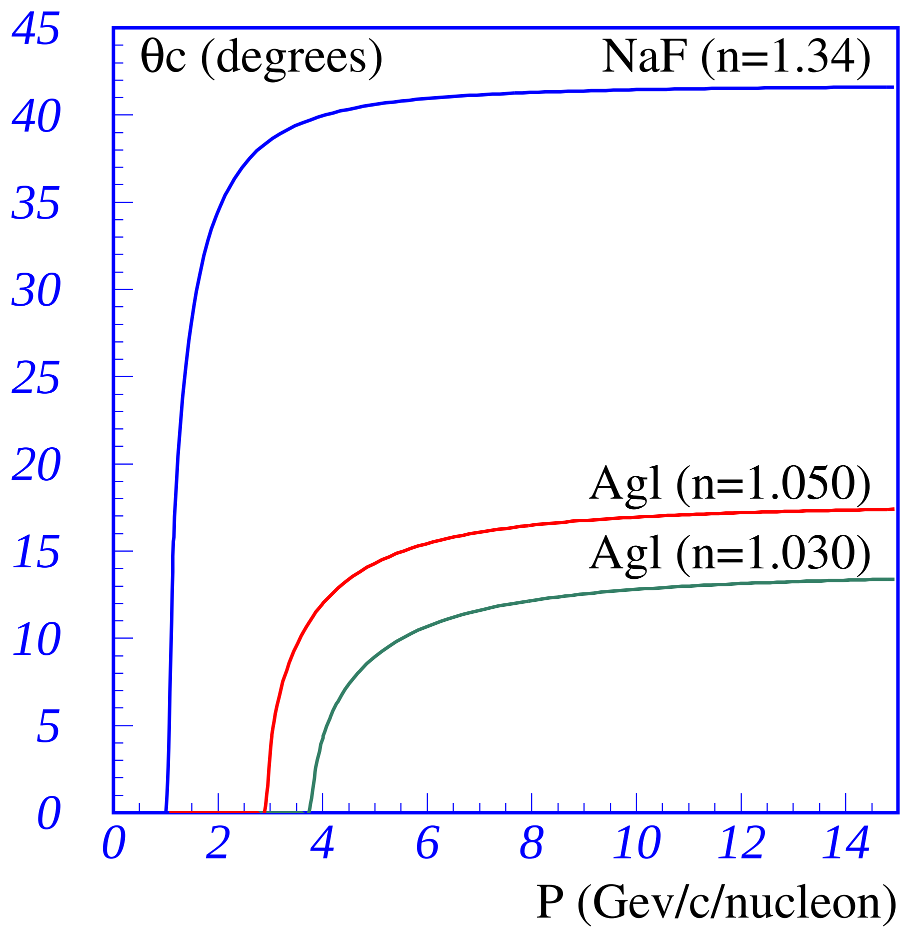
RICH radiators

Aerogel

- n=1.030/1.050
- light yielding:
  $\sim$ 50/*cm* - $\sim$ 85/*cm*
- scattering and absorption
  $\Lambda \sim 3.5cm$
- chromaticity

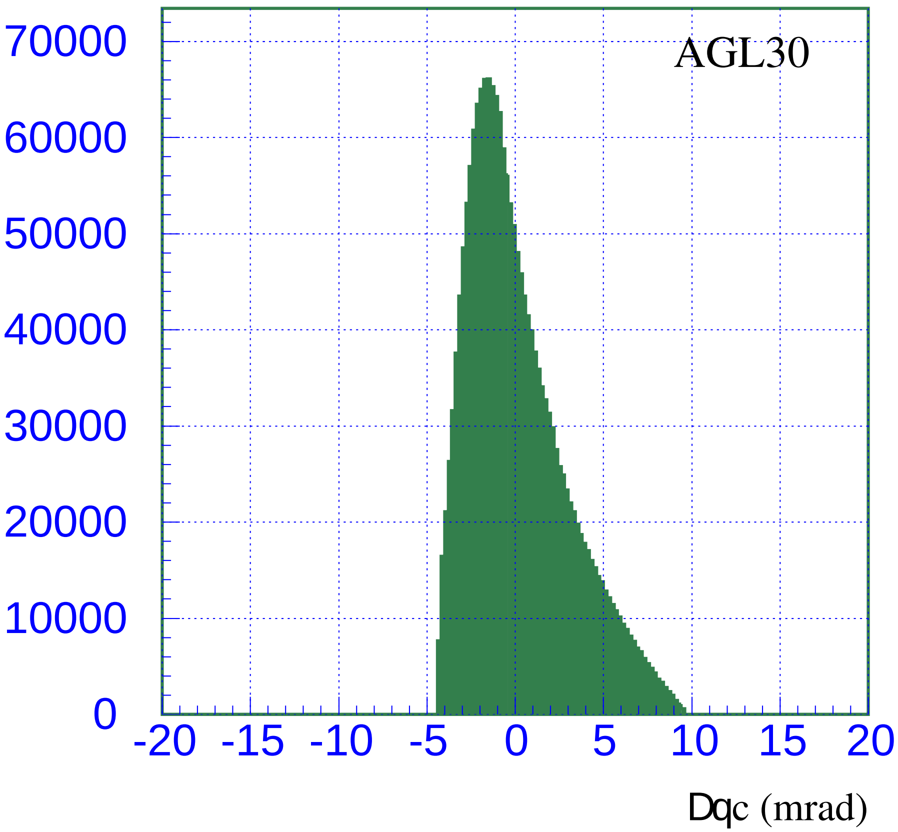
NaF

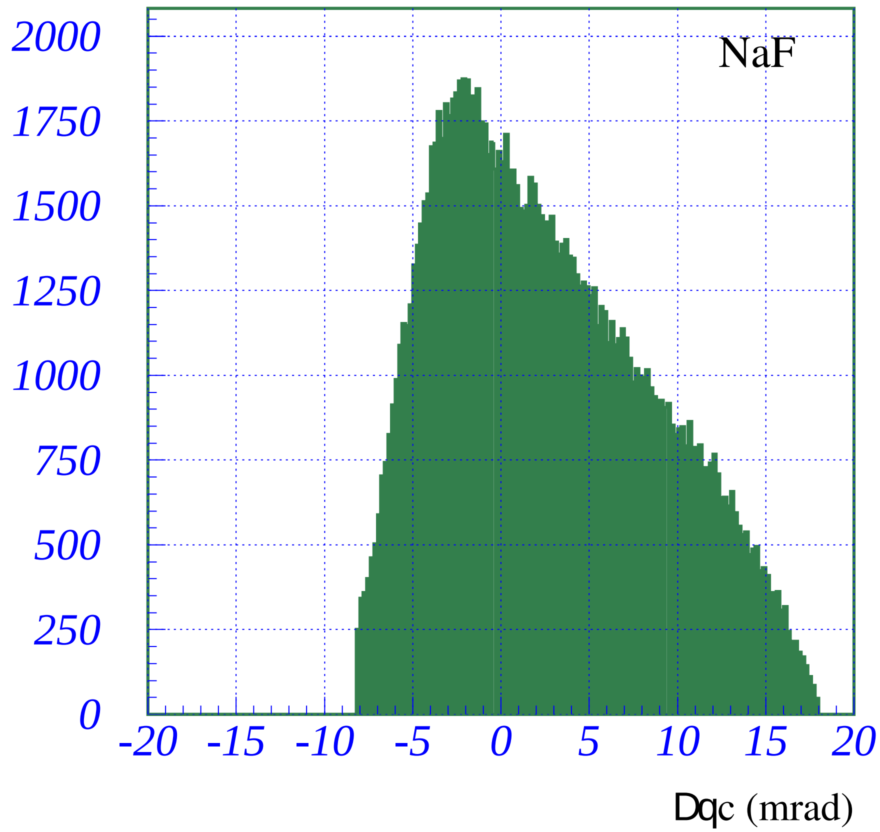
- n=1.33
- light yielding:
  $\sim$ 400/*cm*
- no interactions
- larger chromaticity effects
- lower event geom acceptance
- lower light guide efficiency



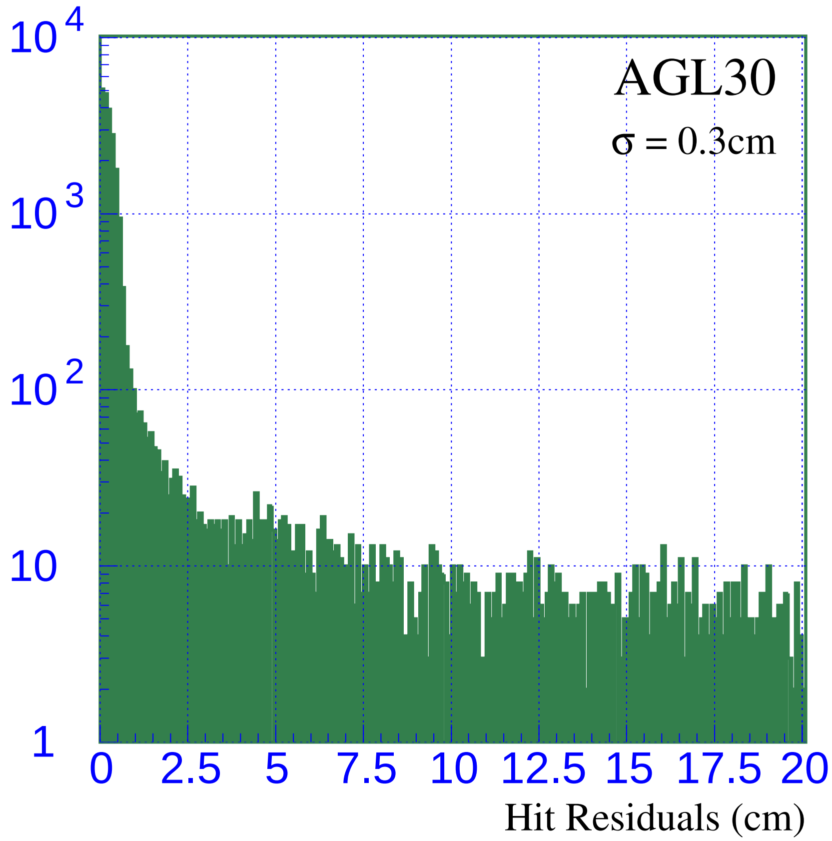
Chromaticity dispersion

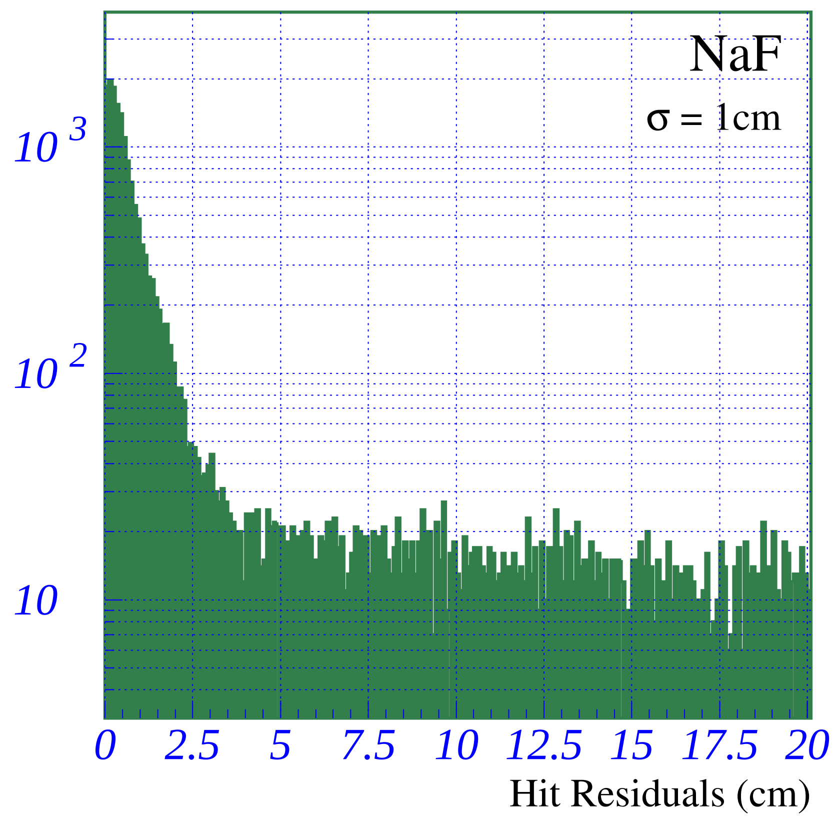
$$cos\theta_c(\lambda) = \frac{1}{\beta\ n(\lambda)}$$



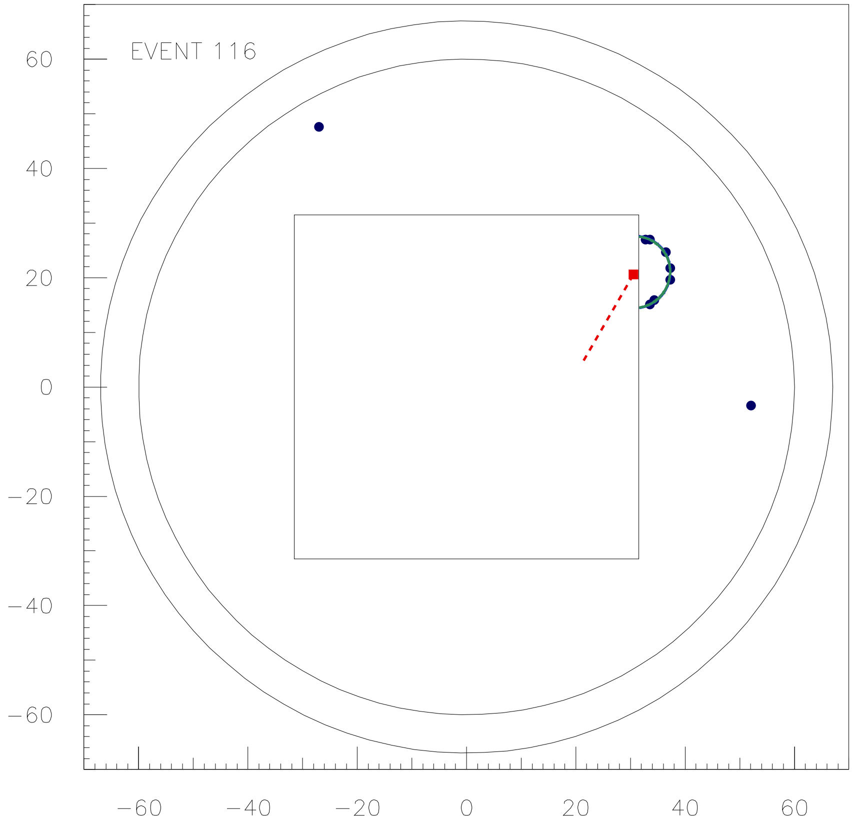


Hit residuals





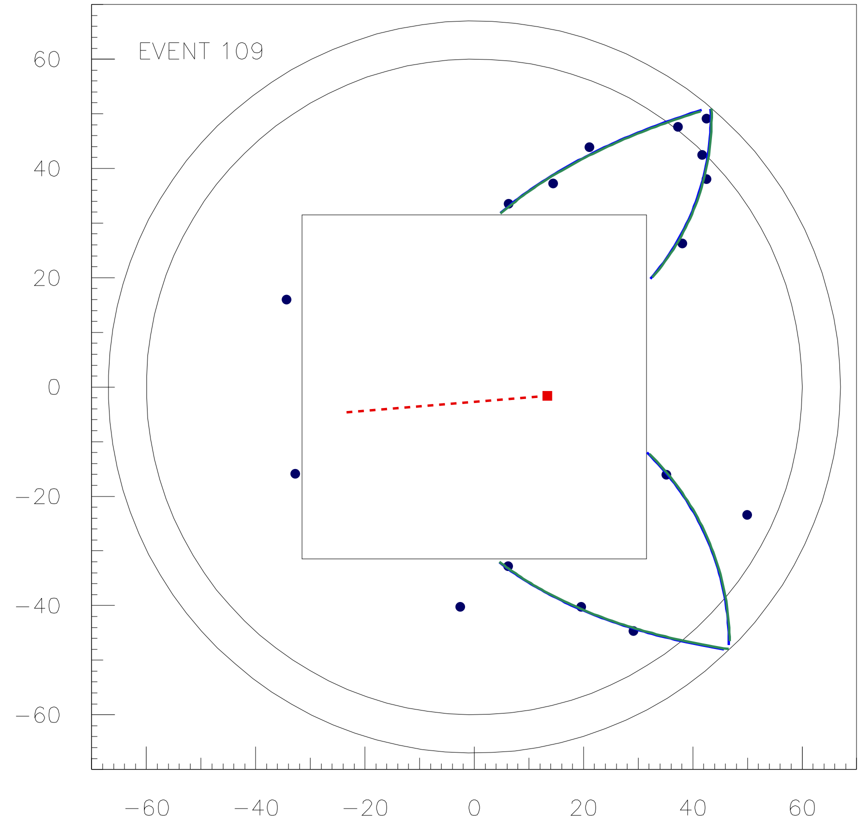
Photon event patterns



AGL30

Beryllium

$p = 1.2\ Gev/c/nuc$



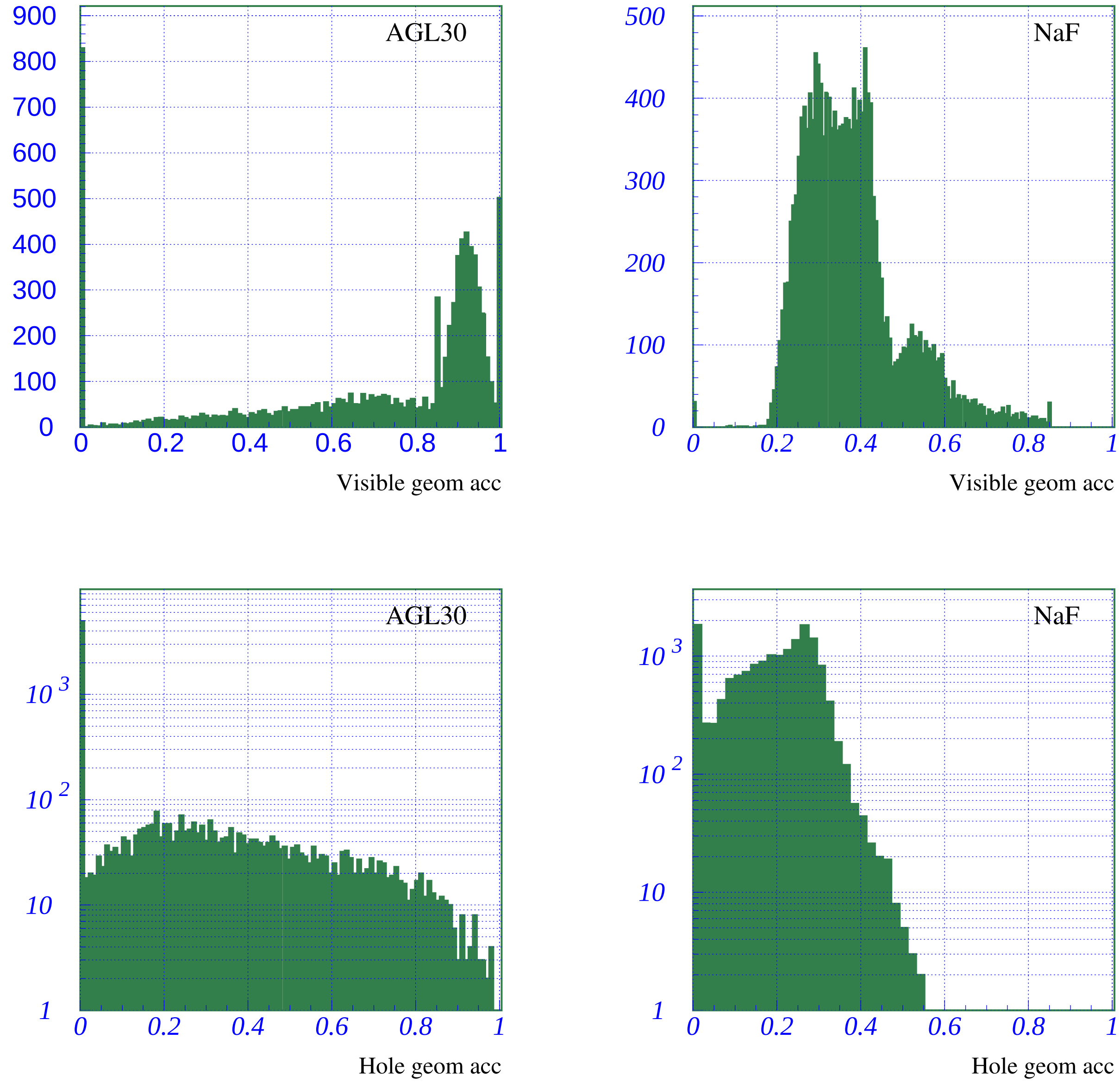
NaF

Beryllium

$p = 1.2\ Gev/c/nuc$

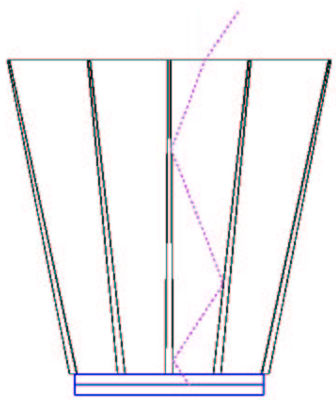
Geometrical acceptance

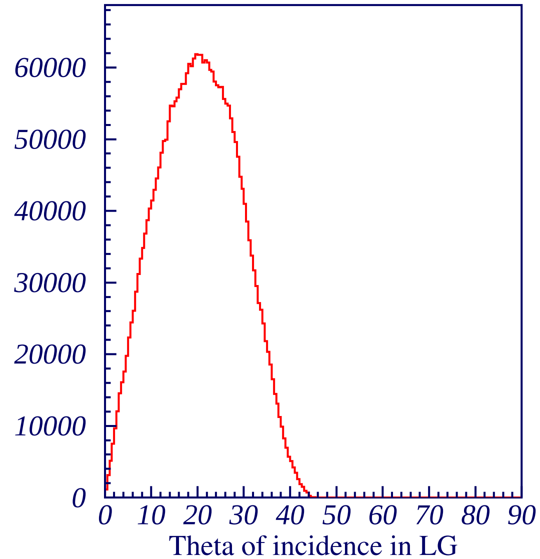
- The fraction of radiated photons seen by the active detector area are different for the two radiators
  - *radiator boundaries*
  - *radiator interactions*
  - *total reflection*
  - *mirror*
  - *ecal hole*

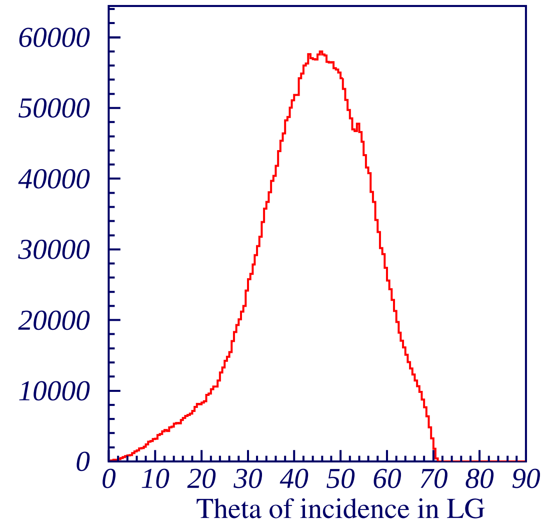


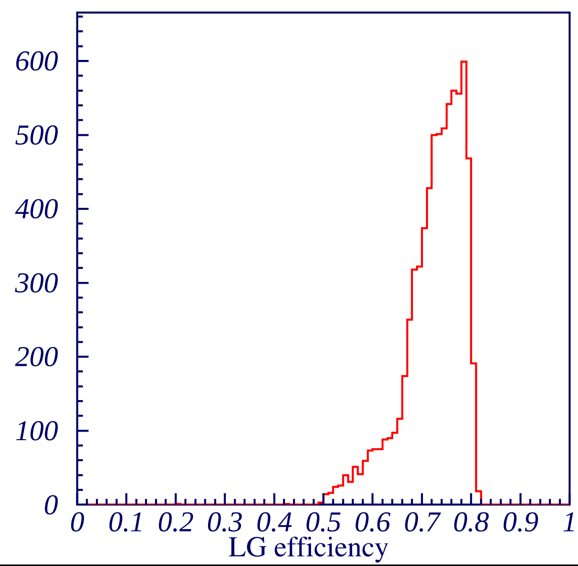
Light Guide Efficiency

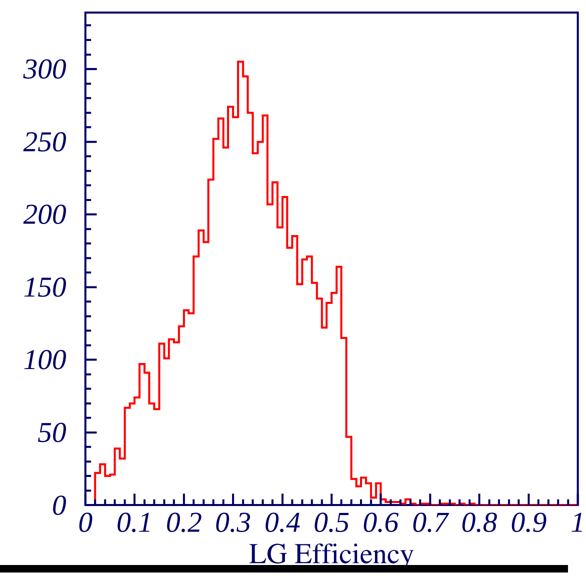
- The light guide efficiency depends on the photon entrance angle (θ_γ)
  - NaF radiated photons have larger entrance angles and therefore lower efficiencies





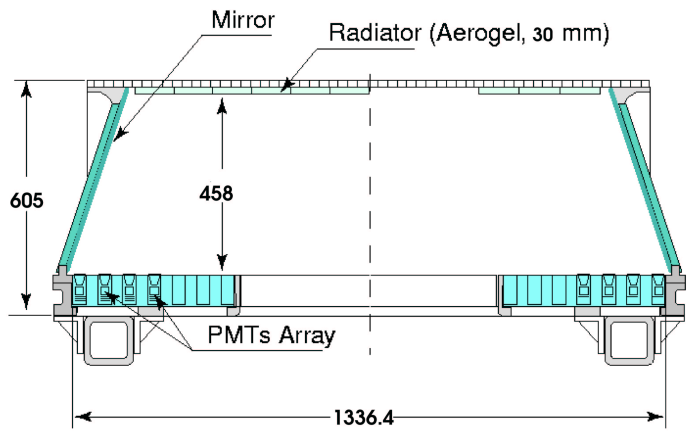






Light Yield: NaF.vs.Agl

The number of photons along the detector (folded with the PMT efficiency)



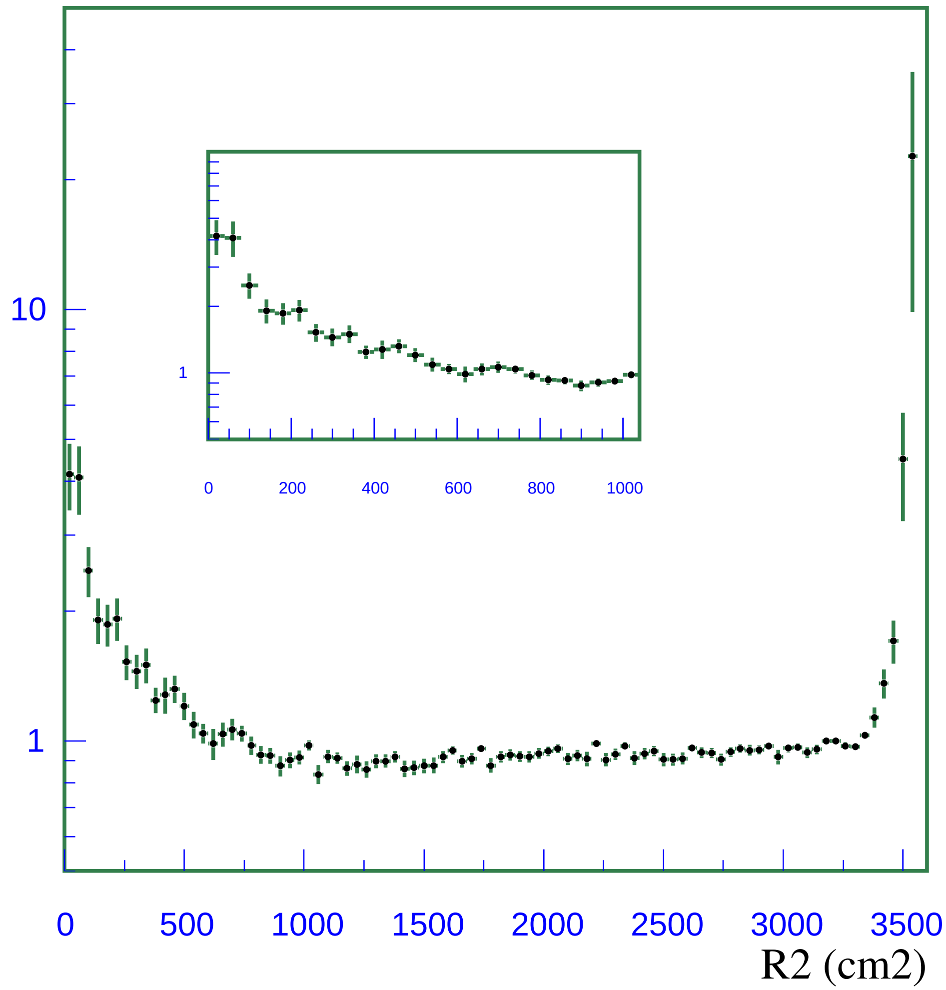
Light Yield	NaF (0.5cm)	Agl30 (3cm)
N_{γ}^{rad}	138	105
	33% (total refl+foil)	45% (rad int+foil)
$N_{\gamma}^{out\ radiator}$	46	47
	37% (geom acc)	50% (geom acc)
$N_{\gamma}^{lg\ entrance}$	17	24
	41% (lg eff)	75% (lg eff)
$N_{\gamma}^{pmt\ cathode}$	7	18

Which size for NaF?

- A minimal number of 3 hits required on θ_c reconstru c- tion
- The ratio of the events reconstructed on **NaF** and **Agl30** as function of the incident particle distance to the radiator center

$$\frac{\%\ Recevents(NaF)}{\%\ Recevents(Agl30)}$$

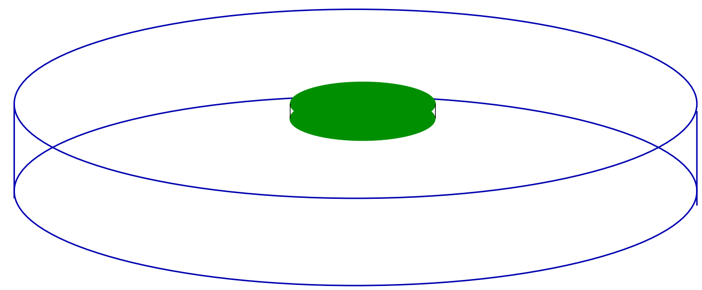
- NaF reconstruction is dominant for
  $R < 15\ cm$
  $R > 58\ cm$



$\beta \sim 1$

Typical NaF configuration

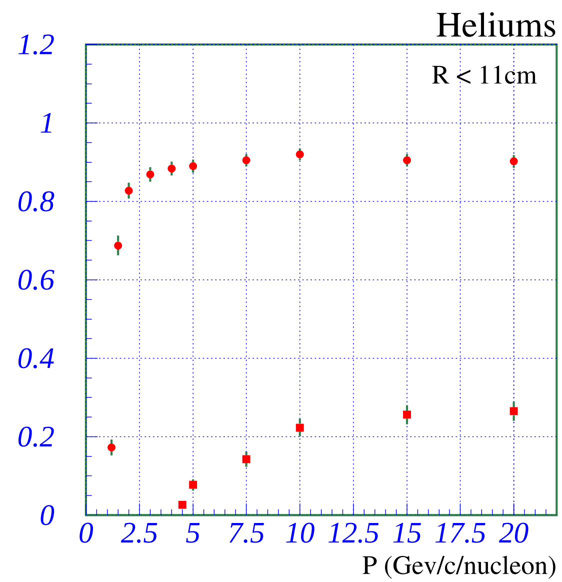
- The RICH acceptance would be increased with a small area of NaF radiator
- The momentum range covered would be enlarged to lower values
- The NaF radiator could be placed at the radiator center with a typical radius of $\sim$ **11** $\boldsymbol{cm}$ and a thickness of **0.5** $\boldsymbol{cm}$
  eventually a square with 22cm
- The NaF corresponding weight would be
  $\mathbf{2.56}\, \boldsymbol{gr/cm^3} \times \mathbf{190}\, \boldsymbol{cm^3} \sim \mathbf{0.5}\, \boldsymbol{kg}$

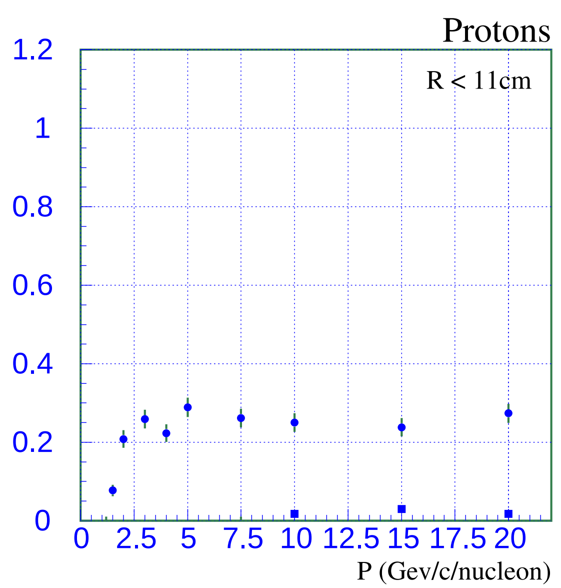


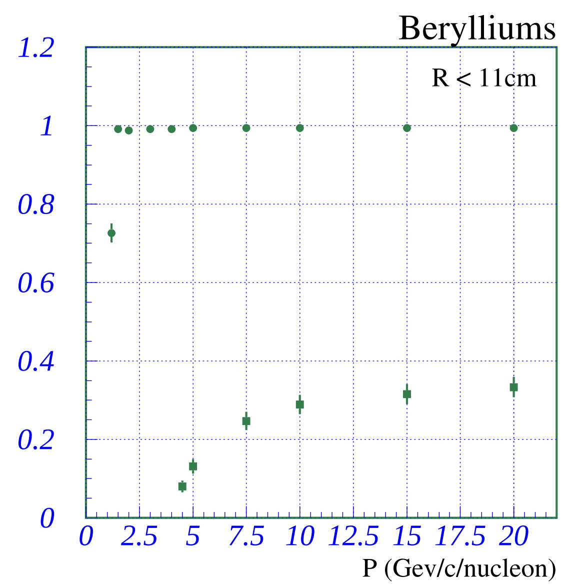
θ_c Reconstruction efficiency

- NaF radiator area corresponds to $\sim$ **3%** of the RICH acceptance
- The fraction of particles impinging on the NaF area and being reconstructed ($N_hits > 2$) depends strongly on the charge

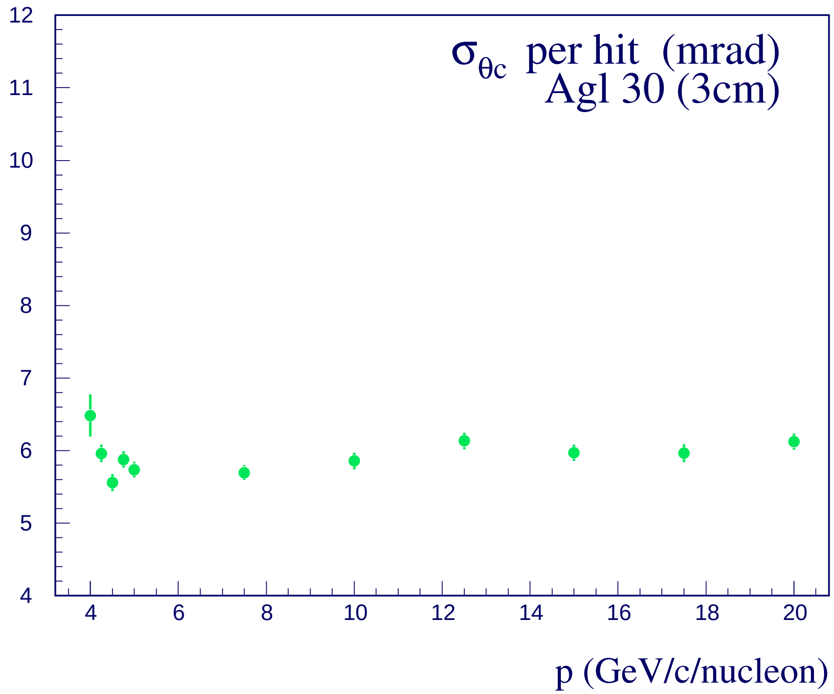
  NaF efficiency reaches 100% for Berylliums
- NaF and Agl30 efficiencies are compared

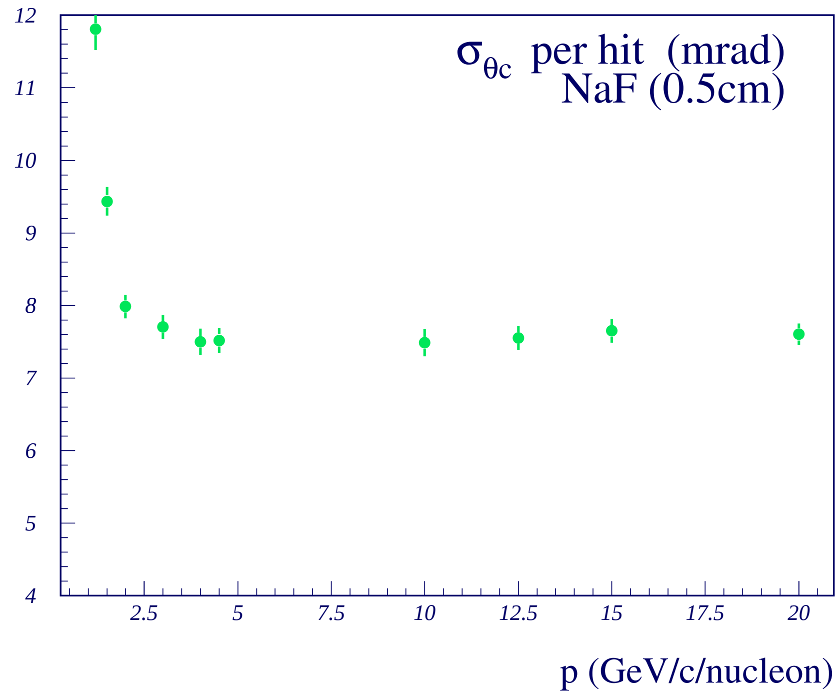






θ_c: Single Hit resolution





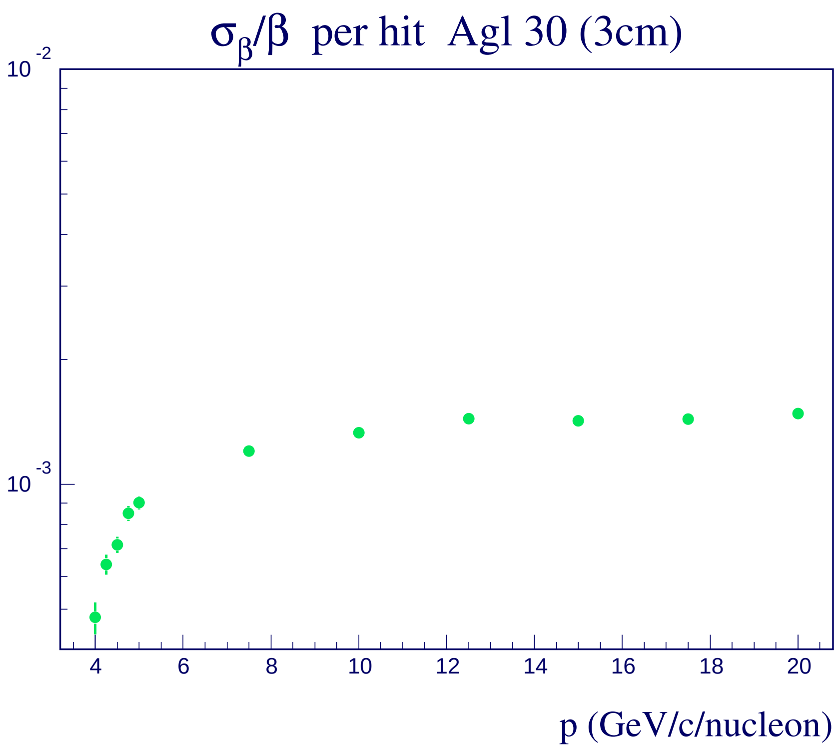
Agl30

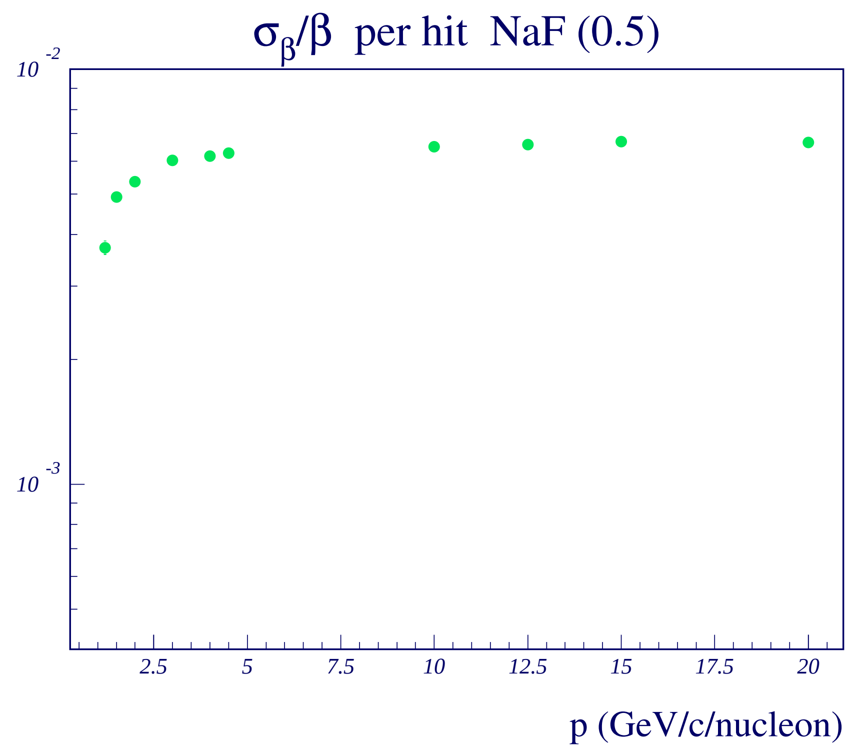
$\sigma_{\theta_c} \sim 6\ mrad\ (\beta \sim 1)$

NaF

$\sigma_{\theta_c} \sim 7.5\ mrad\ (\beta \sim 1)$

$\Delta\beta/\beta$: Single Hit resolution





Agl30

$\frac{\Delta\beta}{\beta} \sim 0.15\% \ (\beta \sim 1)$

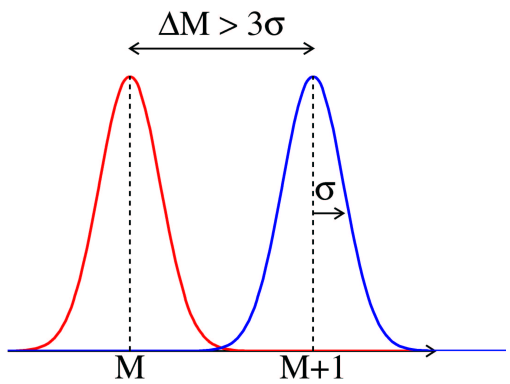
NaF

$\frac{\Delta\beta}{\beta} \sim 0.6\% \ (\beta \sim 1)$

Particle Mass Identification

- Particle mass identification requires precise measurements on **momentum (p)** and **velocity (β)**
- AMS resolutions:
  - $\boldsymbol{\Delta p/p \lesssim 2\%}$ up to 50 GeV/c (protons)
  - Single Hit velocity resolution (from simulation studies)

p (Gev/c/nucleon)	AGL30(%)	NaF(%)
1.5	-	0.35
2.0	-	0.55
3.0	-	0.60
4.0	0.05	0.63
5.0	0.09	0.64
7.5	0.12	0.65
10.0	0.13	0.65

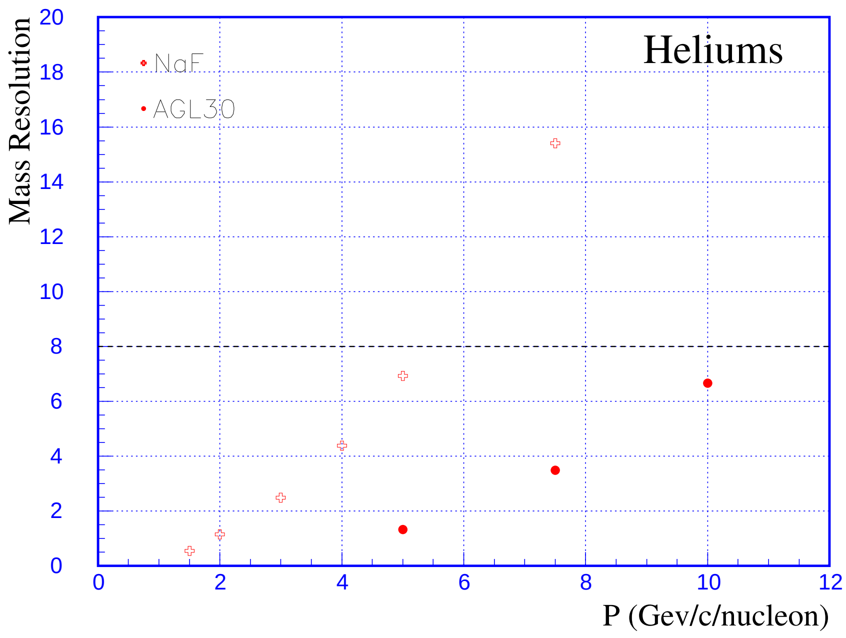


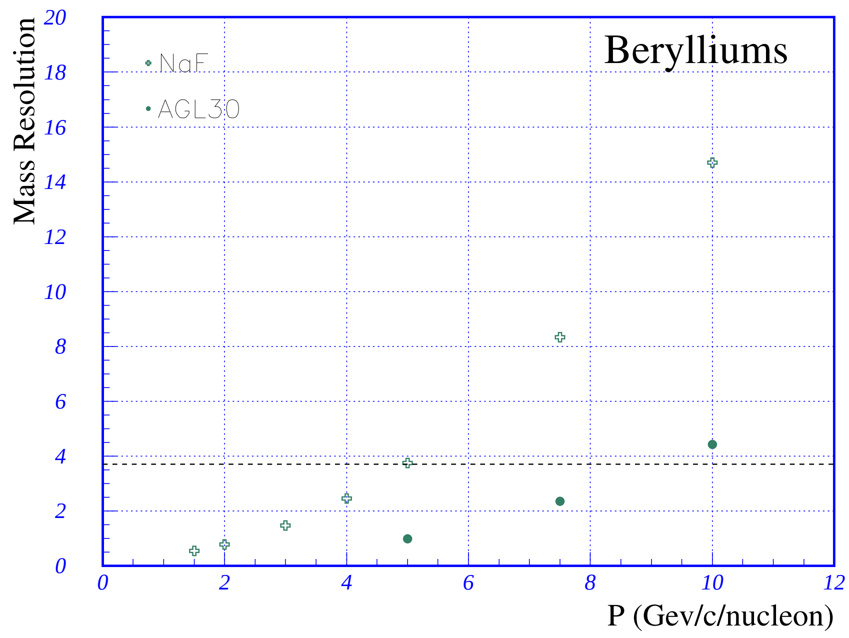
- mass resolution:
  $\frac{\sigma_M}{M} = \frac{\Delta p}{p} \oplus \gamma^2 \frac{\Delta\beta}{\beta}$
- Mass separation criterium ($\boldsymbol{\Delta M > 3\sigma_M}$)
  $\frac{\sigma}{M} < \frac{1}{3}\frac{\Delta M}{M}$

Mass Resolution

- Events impinging on the center of the radiator (R<11cm) have different number of hits close to the cerenkov ring, depending on the radiator type
  AGL: Heliums ∼ 5 berylliums ∼ 10
  NAF: Heliums ∼ 7 berylliums ∼ 20

- The velocity resolution can be scaled from the single hit one





Conclusions

- The possibility of having a mixed radiator configuration with both a large and a low refractive index radiators, was studied
- Aerogel radiator shows low event geometrical acceptances for particles impinging close to the radiator center
- The placement of a NaF radiator at the center of radiator plane ($\boldsymbol{R < 11cm}$) increases at least by 3 the number of reconstructed events (Nhits>2)
- A 90% recontruction efficiency is already obtained for Heliums with P=3 Gev/c/nucl
- With a $\boldsymbol{3\sigma}$ mass separation criterium helium and beryllium isotopes seem to be resolved up to 5 Gev/c/nucl, with the NaF radiator